AMENDMENT TO THE CLAIMS

1.(Currently Amended) A component placing head ~~(100, 200, 300)~~ comprising:

a plurality of component holding members ~~(2)~~ for releasably holding a plurality of components ~~(1)~~;

a plurality of shaft sections ~~(10)~~ detachably equipped with each of the component holding members;

elevation units ~~(20, 220)~~ for executing elevating operations of the component holding members;

a rotating unit ~~(30)~~ for executing rotational operation of each of the component holding members for correction of holding postures of components held by the component holding members; and

a head frame ~~(40)~~ that has shaft support sections ~~(41)~~ for supporting the shaft sections and supports the elevation units and the rotating unit, the component placing head being able to place the plurality of components held by the component holding members on a circuit board,

the shaft sections each comprising:

a spline shaft ~~(11, 211)~~ that has a holding member attaching portion ~~(11a)~~ for detachably equipping with the component holding member at its end portion and is rotatable around an axis (R) of rotation by the rotating unit, elevatable along the axis of rotation by the elevation unit and arranged so as to penetrate the shaft support section;

a first spline nut ~~(12)~~ and a second spline nut ~~(13)~~ that are arranged apart

from each other along the axis of rotation in vicinity of an upper end and a lower end, respectively, of the shaft support section and elevatably support the spline shaft; and

cylindrical members ~~(14, 15 and 16)~~ that have inner peripheral portions fixed to outer peripheral portions of the first spline nut and the second spline nut and join the first spline nut to the second spline nut so as to put the spline nuts into an integrated state, and

the cylindrical members being supported in the vicinity of the upper end and the lower end of the shaft support section rotatably around the axis of rotation via two bearing sections ~~(51, 52)~~, elevatably and rotatably supporting the shaft section by the shaft support section.

2.(Original) The component placing head as defined in claim 1, wherein in each of the shaft sections, the spline shaft and the cylindrical members are processed cutting so that the axis of rotation of the spline shaft coincides with the axes of rotation of the cylindrical members in a state in which the first spline nut, the second spline nut and the cylindrical members are assembled with the spline shaft.

3.(Currently Amended) The component placing head as defined in claim 1, wherein the cylindrical members in each of the shaft sections are integrally formed of:

the first cylindrical member ~~(14)~~ that has a nut fixation portion ~~(14a)~~ whose inner peripheral portion is fixed to the outer peripheral portion of the first spline nut and a support portion ~~(14b)~~ whose outer peripheral portion is supported by one bearing section ~~(51)~~ of the two bearing sections;

the second cylindrical member ~~(15)~~ that has a nut fixation portion ~~(15a)~~ whose inner peripheral portion is fixed to the outer peripheral portion of the second spline nut and a support portion ~~(15b)~~ whose outer peripheral portion is supported by the other bearing section ~~(52)~~ of the two bearing sections; and

the cylindrical joint member ~~(16)~~ that join the first cylindrical member to the second cylindrical member, and

a stepped portion ~~(14c, 15c)~~ is formed between the support portion and the nut fixation portion so that a diameter of the outer peripheral portion of the support portion is smaller than a diameter of the inner peripheral portion of the nut fixation portion at each of the first cylindrical member and the second cylindrical member.

4.(Currently Amended) The component placing head as defined in claim 3, wherein the rotating unit comprises:

a transmission gear section ~~(31)~~ whose inner peripheral portion is fixed to the outer peripheral portion of the support portion of either one of the first cylindrical member and the second cylindrical member in each of the shaft sections;

a cogged belt ~~(32)~~ that internally has a plurality of teeth ~~(32a)~~ capable of being engaged with the transmission gear section and is engaged with the transmission gear section; and

a rotating drive section ~~(34)~~ that rotatively drives the cogged belt, whereby

the support portion is rotatively driven by rotatively driving the transmission gear section around its axis of rotation via the cogged belt by the rotating drive section in

each of the shaft sections, enabling the spline shaft to be rotatably driven via the first spline nut and the second spline nut.

5.(Currently Amended) The component placing head as defined in claim 4, further comprising:

four shaft sections constructed of a first shaft section through a fourth shaft section arranged mutually adjacent in a line as the shaft sections,

wherein the rotating unit comprising:

four transmission gear sections constructed of a first transmission gear section through a fourth transmission gear section ~~(31-1 through 31-4)~~ attached to the first shaft section to the fourth shaft section, respectively, as the transmission gear sections; and

a first cogged belt ~~(32-1)~~ engaged with only the first transmission gear section ~~(31-1)~~ and the third transmission gear section ~~(31-3)~~ among the four transmission gear sections and a second cogged belt ~~(32-2)~~ engaged with only the second transmission gear section ~~(31-2)~~ and the fourth transmission gear section ~~(31-4)~~ as the cogged belts, and

the rotating drive section comprising one rotating drive shaft section ~~(34a)~~ that is engaged with the first cogged belt and the second cogged belt and is able to rotatively drive both the first cogged belt and the second cogged belt.

6.(Currently Amended) The component placing head as defined in claim 3 ~~or 4~~, wherein each of the elevation units comprises:

a ball screw shaft section ~~(21, 221)~~ supported rotatably around its axis of rotation (S);

a rotating drive section ~~(22, 222)~~ that is fixed to an end portion of the ball screw shaft section and for rotating the ball screw shaft section around the axis of rotation;

an elevation nut section ~~(23, 223)~~ that is meshed with the ball screw shaft section and is elevatable along the axis of rotation center of the ball screw shaft section by the rotation of the ball screw shaft section; and

an engagement member ~~(24, 224)~~ that is fixed to the elevation nut section and engaged with the spline shaft of the corresponding shaft section and is able to move up and down the spline shaft in synchronization with the ascent and descent of the elevation nut section, and

the elevation nut section is elevatable along the axis of rotation in a state in which the rotation of the ball screw shaft section around the axis of rotation is restricted only by the engagement of the engagement member with the spline shaft.

7.(Currently Amended) The component placing head as defined in claim 1,

wherein the shaft sections are arranged mutually in a line,

the elevation units are comprised of a plurality of elevation units that correspond one to one to the shaft sections and for moving up and down the shaft sections along the respective axes of rotation,

each of the elevation units comprises:

a ball screw shaft section ~~(21)~~ supported rotatably around its axis of rotation;

a rotating drive section ~~(22)~~ that is fixed to an end portion of the ball screw shaft section and for rotating the ball screw shaft section around the axis of rotation;

an elevation nut section ~~(23)~~ that is meshed with the ball screw shaft section and is elevatable along the axis of rotation of the ball screw shaft section by the rotation of the ball screw shaft section; and

an engagement member ~~(24)~~ that is fixed to the elevation nut section and engaged with the corresponding shaft section ~~(11)~~ and able to move up and down the shaft section in synchronization with the ascent and descent of the elevation nut section,

the component placing head ~~(300)~~ further comprising:

a light transmission unit ~~(60)~~ that is provided with a light-projecting section ~~(61)~~ and a light-receiving section ~~(62)~~ arranged so as to be opposite to each other in a direction along an array direction of the ball screw shaft sections and able to arrange the elevation nut sections between the light-projecting section and the light-receiving section and able to detect presence or absence of interruption of light by the elevation nut section by receiving the light emitted from the light-projecting section toward the light-receiving section by the light-receiving section;

a plurality of rotational angle detecting sections ~~(71)~~ capable of detecting a rotational angle of the rotating drive section provided for each of the elevation units; and

an origin detection control section ~~(8)~~ is operable to set an origin of elevation of the elevation nut section by detecting the rotational angle by the rotational angle detecting section in each of the elevation units, individually move down the elevation nut sections located in respective set origin positions so that the light emitted from the light-

projecting section is received by the light-receiving section without being interrupted, detect the interruption of light emitted from the light-projecting section by the lowered elevation nut section by the light-receiving section in a position where the elevation nut section is lowered from each of the set origins by a prescribed light interruption dimension, thereby confirming the fact that the set origins are origins of elevation to execute the detection of the origins.

8.(Currently Amended) The component placing head as defined in claim 7, wherein each of the elevation units further comprising:

an overload detecting section ~~(72)~~ capable of detecting overload of the rotating drive section; and

restricting portions ~~(43, 44)~~ that are fixed to the ball screw shaft section while being located apart from each other and for restricting mechanically the upper end position and the lower end position of elevation of the elevation nut section, and

the origin detection control section is operable to reverse the rotational direction of the rotating drive section when the overload of each of the rotating drive sections is detected by the respective overload detection section by moving each of the elevation nut sections to the upper end position of the elevating operation and bringing each of the elevation nut sections in contact with the restricting portion in the upper end position, and detect the rotational angle by the rotational angle detection section in each of the elevation units after the reversing, whereby set the position along the axial center of the elevation nut section when the origin of rotation of the rotating drive section is detected at a

first time as the origin of elevation.

9.(Original) The component placing head as defined in claim 7, wherein the light-projecting section and the light-receiving section are arranged so that the light emitted from the light-projecting section can be transmitted and received by the light-receiving section in each of positions located apart by the prescribed light interruption dimension downwardly along the axis of rotation of each of the ball screw shaft sections from each of the origins.

10.(Currently Amended) The component placing head as defined in ~~any one of claims 7 through 9~~ claim 7, wherein each of the elevation nut sections can consistently interrupt the light emitted from the light-projecting section in the position of elevation of the elevation nut section between each of positions located apart by the prescribed light interruption dimension downwardly along each of the axes of rotation from each of the origins and a lower end position of elevation of the elevation nut section.

11.(Currently Amended) An origin detection method for a component placing head ~~(300)~~ having:

a plurality of shaft sections ~~(11)~~ that has an end portion provided with a plurality of component holding members ~~(2)~~ for releasably holding components ~~(1)~~ and are arranged in a line;

a plurality of elevation units ~~(20)~~ that correspond one to one to the shaft sections and for moving up and down each of the shaft sections along its axis of rotation,

the elevation units ~~(20)~~ being comprised of,

a ball screw shaft section ~~(21)~~ supported rotatably around its axis of rotation,

a rotating drive section ~~(22)~~ that is fixed to an end portion of the ball screw shaft section and for rotating the ball screw shaft section around the axis of rotation,

an elevation nut section ~~(23)~~ that is meshed with the ball screw shaft section and is elevatable along the axis of rotation of the ball screw shaft section by the rotation of the ball screw shaft section, and

an engagement member ~~(24)~~ that is fixed to the elevation nut section and engaged with the corresponding shaft section and able to move up and down the shaft section in synchronization with the ascent and descent of the elevation nut section; and

a light-projecting section ~~(61)~~ and a light-receiving section ~~(62)~~, which are arranged opposite to each other in a direction along an array direction of the ball screw shaft sections and are able to arrange each of the elevation nut sections between the light-projecting section and the light-receiving section and are able to detect the presence or absence of the interruption of light by the elevation nut section by receiving the light emitted from the light-projecting section toward the light-receiving section by the light-receiving section, whereby the components held by the component holding members are placed on the circuit board,

the method comprising:

setting an origin of elevation of the elevation nut section by detecting the rotational angle of the rotating drive section in each of the elevation units;

individually moving down the elevation nut sections located in the respective

set origin positions so that the light emitted from the light-projecting section is received by the light-receiving section without being interrupted; and

confirming the fact that each of the set origins are origins of elevation by detecting the interruption of light emitted from the light-projecting section by the lowered elevation nut section by the light-receiving section in a position where the elevation nut section is lowered from each of the set origins by a prescribed light interruption dimension to execute the detection of the origins.

12.(Original) The origin detection method for the component placing head defined in claim 11, wherein,

moving each of the elevation nut sections to an upper end position of its elevating operation,

reversing the rotational direction of the rotating drive section when overload of each of the rotating drive sections is detected at each of the upper end positions, and

detecting the rotational angle of each of the elevation units after the reversing, the position along the axis of rotation of the elevation nut section when the origin of rotation of the rotating drive section is detected at a first time can be set as the origin of elevation.

13.(Original) The origin detection method for the component placing head defined in claim 11, wherein the light-projecting section and the light-receiving section are arranged so that the light emitted from the light-projecting section can be transmitted and received by the

light-receiving section in each of positions located apart by the prescribed light interruption dimension downwardly along the axis of rotation of each of the ball screw shaft sections from each of the origins.

14.(Currently Amended) The origin detection method for the component placing head defined in ~~any one of claims 11 through 13~~ claim 11,

wherein each of the elevation nut sections can consistently interrupt the light emitted from the light-projecting section in the position of elevation of the elevation nut section between each of positions located apart by the prescribed light interruption dimension downwardly along the axis of rotation from each of the origins and a lower end position of elevation of the elevation nut section, and

movement of each of the component holding members in a direction along a surface of the circuit board is inhibited in the state in which light is interrupted.